A Summary of Fish Habitat and Population Changes in Flat Creek, Upper Selway River Drainage, One Year After the 2000 Wilderness Complex Fires

Bitterroot National Forest

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Introduction

The Wilderness Complex Fires burned 47,731 acres in the Upper Selway River drainage in August and September, 2000. The majority of the area was burned at low severity (76% of the acres); however, certain watersheds received larger amounts of moderate and high severity burn. The Flat Creek watershed (CRB 6th code HUC 170603010702) was one of the more severely burned fish-bearing watersheds. Pre-fire fish habitat and population data was available for Flat Creek as a result of an R1/R4 fish habitat inventory that was conducted by the Bitterroot National Forest in 1994. The objective of this study was to re-survey Flat Creek one-year after it was burned, using the same R1/R4 methodology, to detect and document any habitat and population changes that could have occurred as a result of the 2000 fires.

Study Area

Flat Creek is a 3rd order tributary to the Little Clearwater River (CRB 5th code HUC 1706030107). Flat Creek enters the Little Clearwater River approximately six miles upstream from the Little Clearwater's confluence with the Selway River. The mouth of the Little Clearwater River is located at river mile 76. Flat Creek originates in the high country (elevation 8,000 feet) near Observation Point, and drops relatively steeply for about seven miles before emptying into the Little Clearwater River at an elevation of 4,560 feet. The upper third of Flat Creek consists of a moderately confined B3 stream channel. The lower two-thirds consist of a steeper gradient, more confined A2/A3 stream channel. The mean base flow wetted width of Flat Creek ranges between 15-20 feet. Woody debris is abundant throughout Flat Creek, and is the principal habitat-forming feature in the watershed.

Flat Creek supports healthy populations of bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*). Both species are distributed throughout Flat Creek, from near the headwaters to the mouth. Fluvial and resident life history forms of bull trout and westslope cutthroat trout occur in Flat Creek. Steelhead trout (*Oncorhynchus mykiss*) and spring chinook salmon (*Oncorhynchus tschawytscha*) occasionally occur in Flat Creek, but at lower numbers, and generally only in the first several miles near the Little Clearwater River. Adult steelhead trout and spring chinook salmon spawn in the Little Clearwater River near the mouth of Flat Creek, and juveniles of these two species are locally common in some years. A few steelhead trout and spring chinook salmon may spawn in the lower end of Flat Creek from time to time, but there are no known concentrated areas of spawning activity. Non-native fish species do not

occur in Flat Creek or the Little Clearwater River. Native sculpin (*Cottus* spp.) and mountain whitefish (*Prosopium williamsoni*) are present in the Little Clearwater River near the mouth of Flat Creek, but have not been observed in Flat Creek.

The Flat Creek watershed is 9,162 acres in area. The 2000 Wilderness Complex Fires burned about 60% of those acres, predominantly in the lower half of the watershed and the Chuckling Creek tributary. The upper third of the Flat Creek drainage was unburned. Burn severity in the Flat Creek drainage was approximately: 10% high severity; 20% moderate severity; 20% low severity; and 40% unburned. Mudslides are not known to have occurred in the Flat Creek drainage during 2000 or 2001.

Methods

Bitterroot National Forest fisheries crews surveyed three reaches in Flat Creek in June 1994 using the R1/R4 fish habitat inventory methodology (Overton et al., 1997). Following the habitat survey, randomly selected habitat units were snorkeled in July 1994 to determine fish species presence, distribution, and densities. The FBASE software program was used to enter the data and produce summary reports.

During July and August 2001, one year after the 2000 Wilderness Comples Fires burned the watershed, Bitterroot National Forest fisheries crews resurveyed the same three reaches in Flat Creek using the same R1/R4 inventory methodology as the 1994 survey. Following the habitat survey, randomly selected habitat units were snorkeled. The same sampling intervals for snorkel units and Wolman pebble counts were used in 1994 and 2001. The FBASE software program was used to enter the data and produce summary reports. The 1994 and 2001 data were compared to assess potential changes in habitat conditions and fish populations that may have occurred as a result of the 2000 fires.

Before discussing the results of the data comparison, there are several important points that should be emphasized:

- Basinwide survey techniques, such as the R1/R4 methodology, are designed to inventory existing conditions at <u>the watershed scale</u>. They are not well suited for precise monitoring, or for detecting very small differences at the habitat unit scale. That being stated, they are useful in detecting <u>broad-scale trends</u> such as those discussed in this study.

- There are two primary sources of error inherent to basinwide survey techniques: (1) observer bias in designating habitat unit types (i.e. is it a pool or not a pool?), and (2) different stream flow discharges when surveys are conducted. In order to compare surveys between different years, stream flow discharges should be similar.

Observer bias is inherent in all habitat survey methods that rely on some level of ocular estimation or classification, but it can be minimized with good crew training and quality control. In this study, we used different crews in 1994 and 2001. However, both crews

were well-trained, and our quality control observations do not indicate any major concerns in the area of observer bias.

In order to minimize bias, basinwide surveys should be conducted at relatively equal stream flow discharges (i.e. base flows) in order to allow for accurate year-to-year comparisons of the data. That didn't occur in this study because the 1994 survey was conducted earlier in the summer (June and early July, 1994), prior to the arrival of base flows. As a result, discharges during the 1994 survey were roughly 2+ times higher than those encountered during the 2001 survey. This source of error affects certain variables more than others, and is discussed in the results section below.

Results

Habitat Length and Area

We surveyed the same 5.7-mile long section of Flat Creek in 1994 and 2001. This section was divided into three reaches (see table below). The same reach breaks were used in 1994 and 2001.

Reach	Length (miles)	Predominant channel type
1	2.3	A3
2	2.4	A3
3	1.0	B4

Although we used the same starting and ending points, the measured length of the 2001 survey was about 423 meters longer than the 1994 survey (1994 = 8648 m; 2001 = 9071 m). It is not known if that difference was caused by actual increases in stream sinuousity between 1994 and 2001, or by small differences in the measurements of individual habitat units that gradually accumulated over the 5.7-mile length of the survey.

The area of habitat that was surveyed was similar between the two years (1994 = 45,095 m^2; 2001 = 44,688 m^2).

Burn Severity

In 1994, the entire length of Flat Creek was unburned. In 2001, as part of our survey, we measured the length and type of burn severity that occurred in the riparian area as a result of the 2000 fires. Those burn severities are:

Reach	% and length of unburned	% and length of low severity burn	% and length of moderate severity burn	% and length of high severity burn
1	0%	40% (1481 m)	55% (2035 m)	5% (165 m)
2	18% (647 m)	21% (803 m)	42% (1482 m)	19% (733 m)
3	100% (1625 m)	0%	0%	0%
Total	25% (2272 m)	25% (2284 m)	40% (3617 m)	10% (898 m)

75% of the Flat Creek riparian area was burned by the 2000 fires, but only 10% (about 900 meters) was burned at high severity. Moderate severity was the most prevalent burn pattern (55% of reach 1; 42% of reach 2). Reach 2 had the highest percentage of moderate and high severity burn (61%). Reach 3 was unburned.

Discharge

Discharges were estimated at the start of each reach using the timed rubber ball float technique described in Overton et al. (1997). In 1994, discharges ranged between 0.6 to 0.9 m^3/second. In 2001, discharges ranged between 0.3 to 0.4 m^3/second. The 2+ fold increase in discharge in 1994 was caused by conducting the survey too early in the summer, before stream flows had a chance to completely decline back to base flow levels. The 2001 survey was conducted later in summer at base flows. This difference is discharge is one of the major sources of bias in this comparison. The higher discharges in 1994 resulted in:

- fewer habitat units (1994 = 296 main channel units; 2001 = 527 main channel units)
- an underestimate of pools (1994 = 149 pools; 2001 = 630 pools), and
- an overestimate of fast-water habitat units such as high gradient riffles (1994 = 82% of the habitat length; 2001 = 33% of the habitat length).

Channel dimensions (Mean Wetted Width, Mean Depth, and Wetted Width/Depth Ratio)

Mean wetted width was higher in 1994, most likely due to the higher discharges:

- 1994 = 5.2 m
- 2001 = 4.9 m

Mean depth was higher in 1994. Again, most likely due to the higher discharges:

- 1994 = 0.24 m
- 2001 = 0.19 m

Mean wetted width/depth ratio was lower in 1994, most likely due to the greater depths caused by the higher discharges.

- 1994 = 23
- 2001 = 29

Neither the 1994 or 2001 width/depth ratio even comes close to approaching the default RMO in PACFISH (mean wetted width/depth ratio < 10). However, the ratios we observed are natural features, and are typical of unmanaged wilderness streams in the Idaho wilderness (Overton et al., 1995).

Pools

Nearly all of the pool habitat variables were biased by the higher discharges during the 1994 survey, which likely resulted in an underestimate of pool numbers, area, and volume, and an overestimate in maximum depths.

Pool frequency showed almost a 4-fold increase in 2001:

- 1994 = 149 main channel pools (28 pools/mile)
- 2001 = 630 main channel pools (111 pools/mile)

The 1994 pool frequency was about half of the default PACFISH RMO (56-96 pools/mile). The 2001 pool frequency exceeds the default PACFISH RMO, and is likely to be more representative of the actual pool frequency in Flat Creek.

Similar to the trend for pool frequency, pool area (m^2), % pool habitat, and residual pool volume (m^3) showed an almost 4-fold increase in 2001:

- 1994 = 3,691 m^2 of main channel area consisted of pools (8% of the main channel length)
- 2001 = 13, 913 m^2 of main channel area consisted of pools (31% of the main channel length)

- 1994 = 1,434 m^3 of habitat volume was residual pool volume
- 2001 = 4,159 m^3 of habitat volume was residual pool volume

Mean-maximum pool depths were higher in 1994, probably because only the largest of the pools tended to get designated as pools in 1994, while the shallower pools were masked by the higher discharges and tended to get lumped into fast-water habitat units.

- 1994 = 0.79 m
- 2001 = 0.64 m

Mean residual maximum pool depths, which should be robust to differences in discharge because higher maximum depths would get negated by higher tailcrest depths, were the same in both years. This similarity in mean residual maximum pool depths tends to indicate that the fires of 2000 have not caused a significant reduction in pool volumes as a result of increased sediment infill:

- 1994 = 0.37 m
- 2001 = 0.37 m

Pocket pools

Pocket pools are one of the few pool-related habitat variables that were higher in 1994 than 2001. We suspect the reason for this is that many of the pocket pools that were

counted in 1994 were actually main channel pools that were masked by the higher discharge. Had discharge been at base flows, many of these pocket pools would probably have been designated as main channel pools.

- 1994 = 1,629 pocket pools
- 2001 = 1,098 pocket pools

Large woody debris

The number of large woody debris pieces showed more than a 3-fold increase in 2001:

- 1994 = 1,345 pieces (28 pieces/mile)
- 2001 = 4,448 pieces (111 pieces/mile)

In both years, pool frequency easily exceeded the default PACFISH RMO of 20 pieces per mile. Flat Creek is a stream that is literally choked with woody debris, particularly in reaches 1 and 2. It is unclear why the 2001 count was more than three times the 1994 count? The blow down of burned trees in the past year accounts for some of the increase. The 2001 survey crew observed numerous pieces of woody debris that had fallen over since the fires of 2000. The bias in using different survey crews probably also accounts for some of the increase, but large woody debris is one of the most repeatable of the R1/R4 habitat variables. One thing is clear – there is a lot of woody debris in Flat Creek following the fires of 2000, and likely to be much more over the next several decades.

Percent unstable banks

This variable was not measured in 1994, but was measured in 2001. The fires of 2000 do not appear to have had a significant effect on bank stability. We classified only 8% of the entire bank length as unstable in 2001. This number is not much different than similar unmanaged streams in the unburned condition (Overton et al., 1995).

Percent surface fines

We measured percent surface fines with Wolman pebble counts in randomly selected pool tailouts and low gradient riffles. We used the same sampling interval in 1994 and 2001 (every 10th low gradient riffle and scour pool tailout). Surface fines were consistently lower in 2001, in spite of the fires of 2000:

- 1994 = 23% < 2 mm; 39% < 6.35 mm
- 2001 = 13% < 2 mm; 25% < 6.35 mm

Crew bias probably influences these percentages to some degree, but the fact that surface fines were consistently lower in all of the reaches in 2001 suggests that the fires of 2000 have not contributed significant sediment increases in Flat Creek. If the fires had contributed sediment at the magnitudes that occurred in some streams on the Montana portion of the Forest, those sediment increases would have definitely been reflected in the

Wolman pebble counts. Because we did not detect sediment increases in 2001, we feel confident in saying that the fires of 2000 have not caused significant sediment increases in Flat Creek.

Sidechannels

Sidechannel area (m^2) and volume (m^3) showed a 4-5 fold increase in 2001. The primary cause of this increase was likely the lower discharges that occurred when the 2001 survey was conducted. The higher discharges in 1994 would tend to cover up many of the sidechannels and make them appear as if they were part of the main channel. A lesser cause may be the large increase in woody debris that was observed in Flat Creek in 2001. Woody debris jams are the primary causes of sidechannel formation in Flat Creek.

Fish densities and distribution

Randomly selected habitat units were snorkeled in 1994 and 2001. We used the same snorkel interval in 1994 and 2001 (every 5th pool; every 20th fast-water unit), but due to the larger number of habitat units that were designated in 2001, a corresponding larger area was also snorkeled in 2001 (1994 = 2,956 m^3; 2001 = 3,866 m^3). Because of this difference in snorkel area, we will compare densities in this report, not the total numbers of fish observed.

Three fish species were observed in Flat Creek in 1994. From most numerous to least numerous, those species were:

1. westslope cutthroat trout = 3.76 fish/100 m^2
2. bull trout = 1.15 fish/100 m^2
3. juvenile steelhead trout = 0.10 fish/100 m^2

No other fish species were observed in Flat Creek in 1994.

In 2001, three fish species were observed in Flat Creek. From most numerous to least numerous, those species were:

1. westslope cutthroat trout = 7.09 fish/100 m^2
2. juvenile chinook salmon = 1.03 fish/100 m^2
3. bull trout = 1.01 fish/100 m^2

No other fish species were observed in Flat Creek in 2001. It is very possible that some juvenile steelhead were present, but were mistakenly identified as westslope cutthroat trout. At small sizes, the two species are difficult to distinguish.

The following table summarizes the fish densities observed in 1994 and 2001. Numbers in the table are densities (# fish/100 m^2).

Year	Westslope	Bull trout	Juvenile	Juvenile

	cutthroat trout		chinook salmon	steelhead
1994	3.76	1.15	0	0.10
2001	7.09	1.01	1.03	0

In 1994 and 2001, westslope cutthroat trout and bull trout were observed throughout the entire 5.7-mile length of the survey. A few juvenile steelhead (3 fish) were observed in reaches 2 and 3 in 1994, but were not observed in 2001. As stated above, it is very possible that juvenile steelhead were also present in low numbers in 2001, but were mistakenly identified as westslope cutthroat trout. Westslope cutthroat trout densities in 2001 were nearly double those of 1994, while bull trout densities were similar between the two years. This data clearly indicates that a significant fish kill has not occurred in Flat Creek as a result of the fires of 2000.

A key difference between 1994 and 2001 was the presence of juvenile chinook salmon. In 1994, no salmon were observed. In 2001, 40 juvenile chinook salmon were observed, with almost all of them occurring in reach 1 (38 of the 40). One juvenile chinook salmon was observed in reach 2, and one in reach 3. It is logical that the majority of the juvenile chinook salmon in Flat Creek would occur in reach 1, closest to the Little Clearwater River. Reach 1 contains the largest widths and depths in Flat Creek, and flows into a known salmon spawning and rearing area located between the confluences of Flat and Salamander Creeks. In 1994, juvenile chinook salmon were observed in this part of the Little Clearwater River, but not in Flat Creek.

Water temperatures

Temperatures were not continuously recorded in Flat Creek in 1994, but were continuously recorded with a HOBO-TEMP thermograph at the mouth of Flat Creek in 2001. During the 1994 survey, none of the point measurements taken with a thermometer exceeded 15° C. The warmest temperature recorded was 13° C in late July, 1994.

In 2001, maximum temperatures at the mouth of Flat Creek exceeded 15° C for four days in early August. The warmest temperature recorded was 15.9° C on August 8th. The mean-maximum temperature over the warmest 7-day period of the summer (August 6th to 12th, 2001) was 15.1° C. Between July 18th and October 1st, 2001, Flat Creek accumulated a total of 735 degree-days. This was the coldest of the 15 sites we monitored in the Upper Selway River drainage in 2001.

In summary, the fires of 2000 undoubtably increased water temperatures in Flat Creek to some degree, but without additional years of data to compare to, it is difficult to estimate how much of an increase occurred with any degree of accuracy.

Discussion

Although the differences in discharge confounded the comparison of some habitat variables, several trends are more clearly evident. Our key findings include:

- Based on the densities and distributions of fish we observed in 2001, we can say with a high degree of confidence that the fish community in Flat Creek was essentially unaffected by the fires of 2000. A significant fish kill did not occur in Flat Creek as a result of the fires of 2000.

- We did not observe an increase in surface fines, or a decrease in residual pool volume. Therefore, we can say with a high degree of confidence that significant sedimentation of fish habitat has not occurred as a result of the fires of 2000.

- A large increase in woody debris has occurred in Flat Creek since 1994. Burned trees account for some of that increase. Over the next several decades, the recruitment of burned trees is going to substantially increase woody debris levels in reaches 1 and 2.

- An increase in water temperature occurred in Flat Creek as a result of fire-caused shade losses, but without additional years of data to compare to, it is difficult to estimate how much of an increase occurred with any degree of accuracy.

- We did not observe any significant changes in channel dimensions, or reduction in channel stability, resulting from the fires of 2000. Pools and sidechannels were definitely more numerous in the 2001 survey, but the higher discharges in 1994 confound those results and make comparisons speculative.

Two of the main reasons why we did not observe substantial changes in habitat conditions or the fish community is likely to be the small extent of high severity burn that occurred in the riparian area, and the lack of post-fire mudslides. Those two events are responsible for the majority of negative, short-term changes that occurs to a fishery following fire. Had the amount of high severity burn been greater, or mudslides occurred, we would expect to find much more widespread sedimentation, channel instability, and alterations of the fish community. This occurred in many streams on the Montana portion of the Forest in 2001. On July 16, 2001, at the same time that mudslides were occurring on the Montana portion of the Forest, our survey crews witnessed an intense afternoon thunderstorm that raised the water level of Flat Creek by about five inches for several hours, and dramatically increased turbidities. However, this event was short-lived. Both the water level and turbidities returned to pre-storm levels by nightfall. That was the closest thing to a mudslide that was known to have occurred in the Flat Creek drainage in 2001.

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